US 20120209153A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2012/0209153 A1

(43) Pub. Date: Aug. 16, 2012

FARROW et al.

(54) **DEEP VEIN THROMBOSIS THERAPY DEVICE**

(76) Inventors: **Mark A. FARROW**, Tulsa, OK (US); **Joey ADKINS**, Hinckley, OH (US)

(21) Appl. No.: **13/396,331**

(22) Filed: **Feb. 14, 2012**

Related U.S. Application Data

(60) Provisional application No. 61/442,392, filed on Feb. 14, 2011.

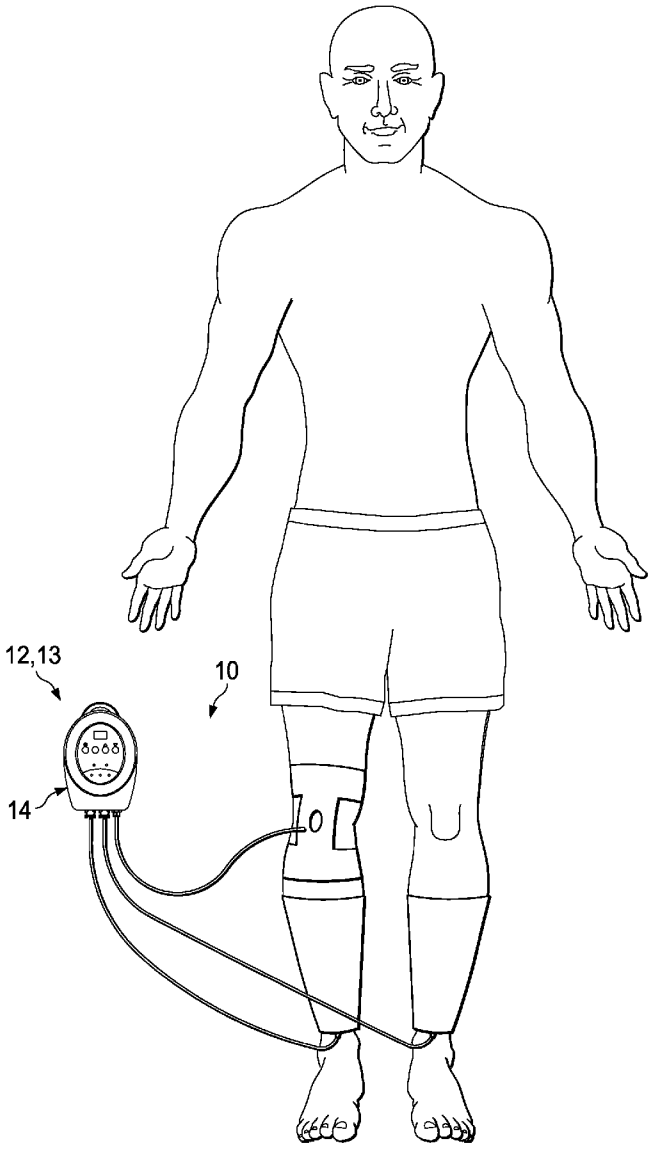
Publication Classification

(51) **Int. Cl.**
A61H 1/00 (2006.01)
A61H 19/00 (2006.01)

(52) **U.S. Cl.** **601/18**; 601/149

(57) **ABSTRACT**

A compression therapy system for treating deep vein thrombosis in disclosed. The system provides sequential, graduated compression to a selected limb or body part. The system includes a portable compression device having multiple outlets. In one embodiment, up to three outputs may be selectively activated by a user. The wraps may be provided with cold therapy wraps. In a second embodiment, the system utilizes a timer to determine which, if any, of several wraps may be attached and inflates a detected wrap to a correct pressure or powers off the system as may be appropriate.



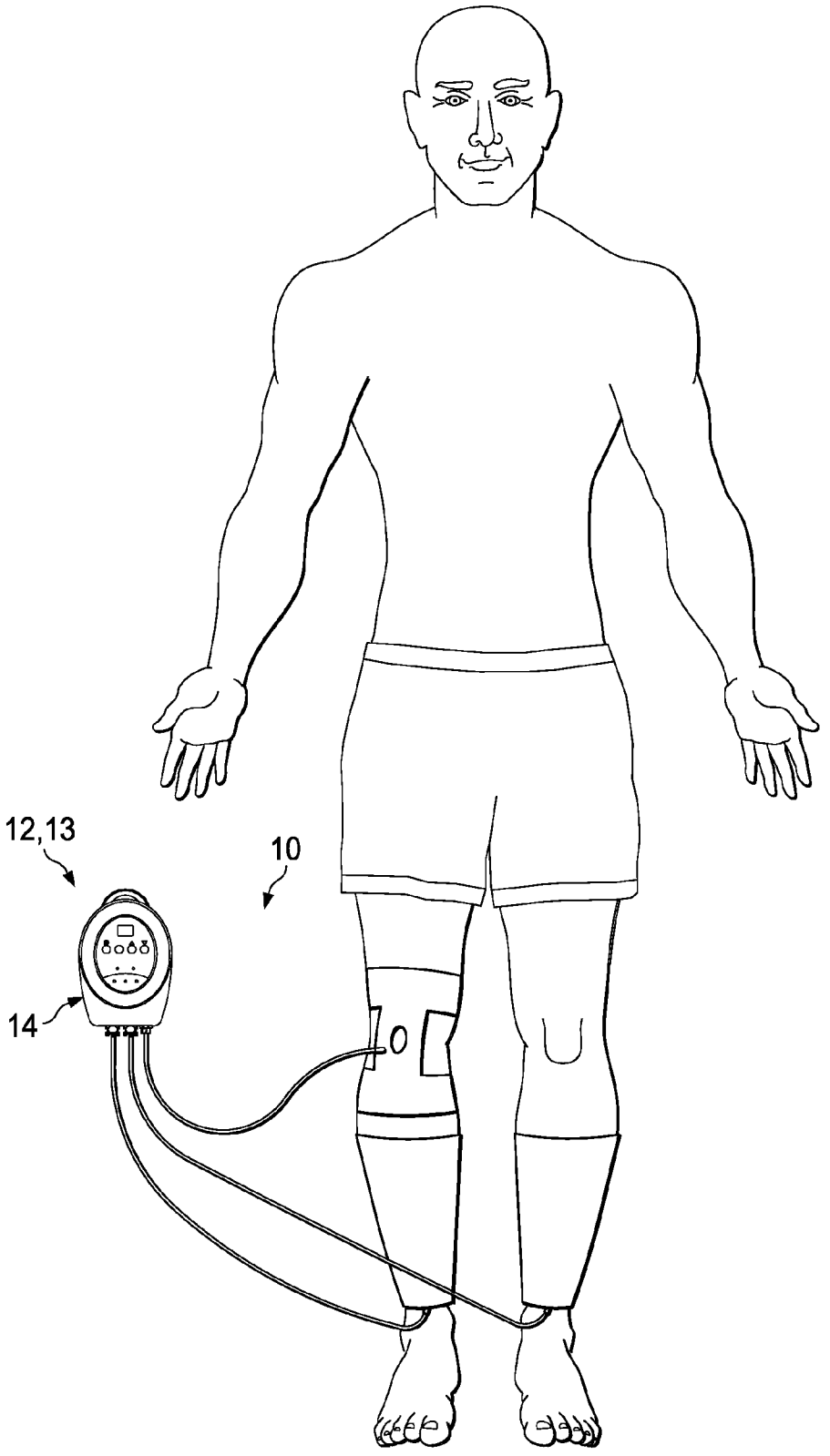


FIG. 1

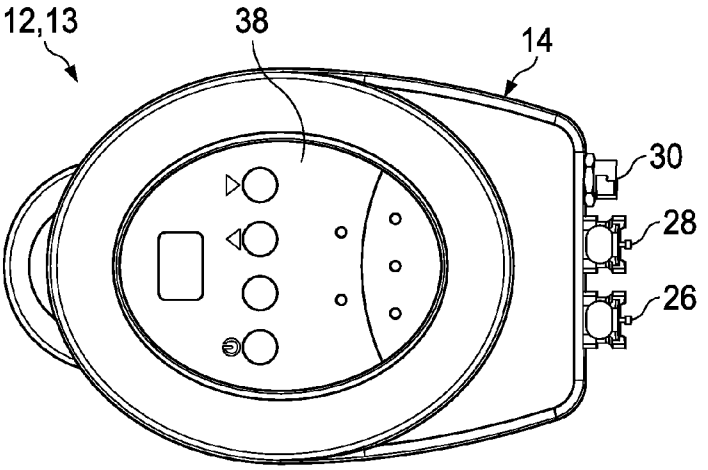


FIG. 2

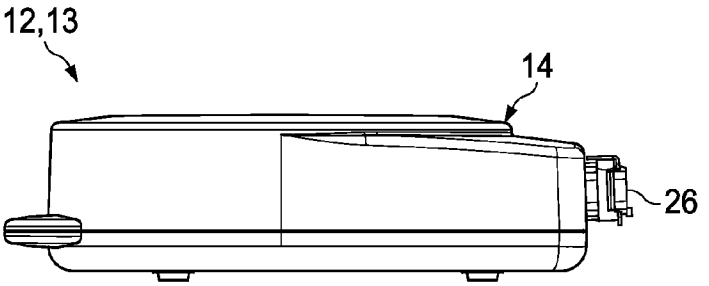


FIG. 3

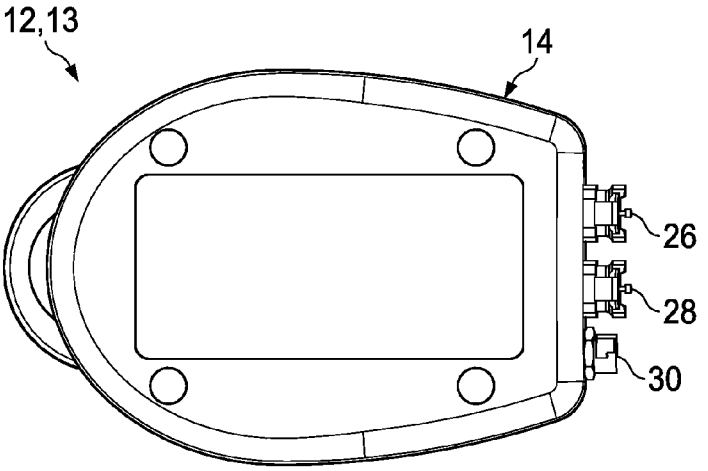


FIG. 4

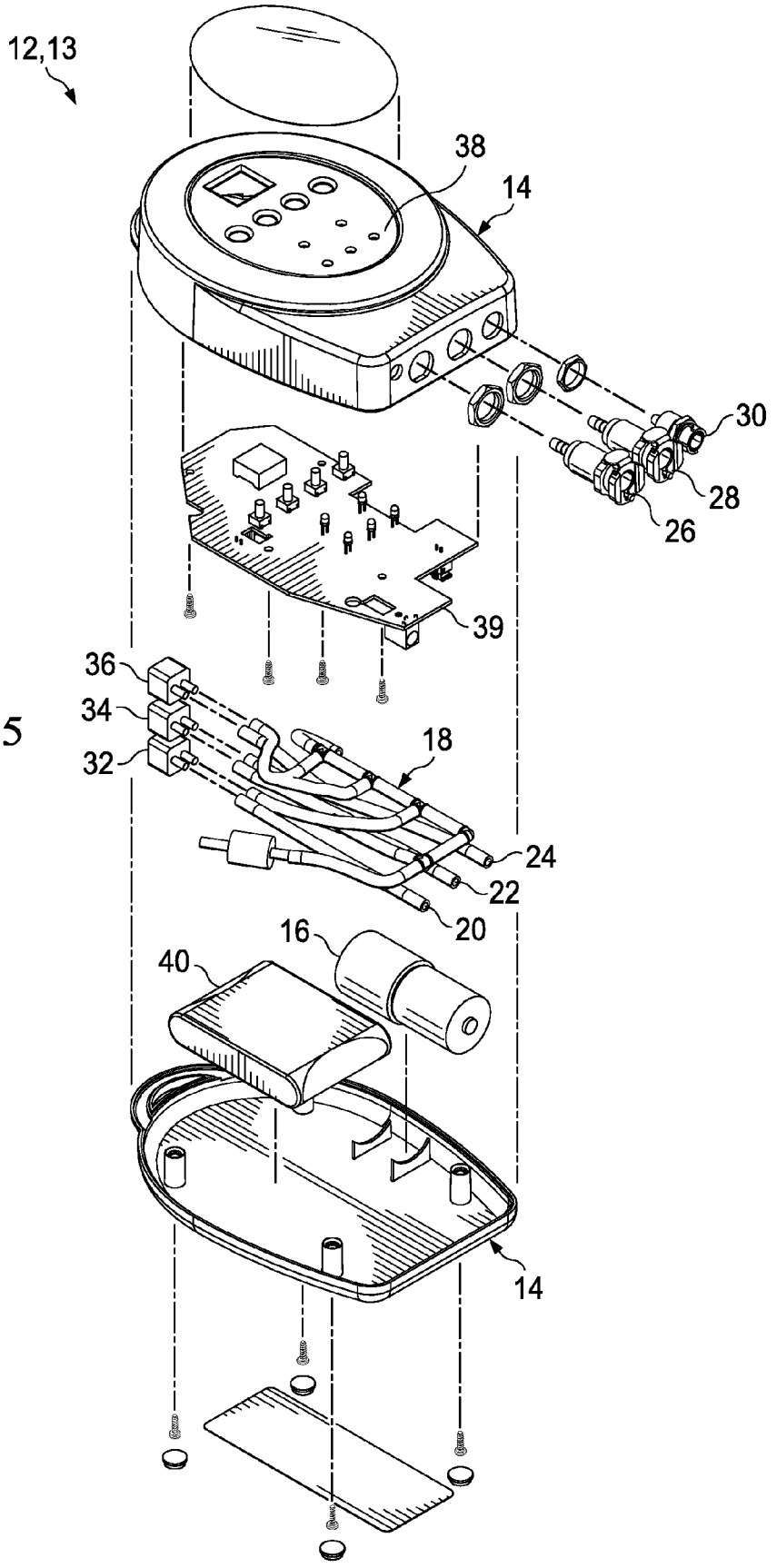


FIG. 5

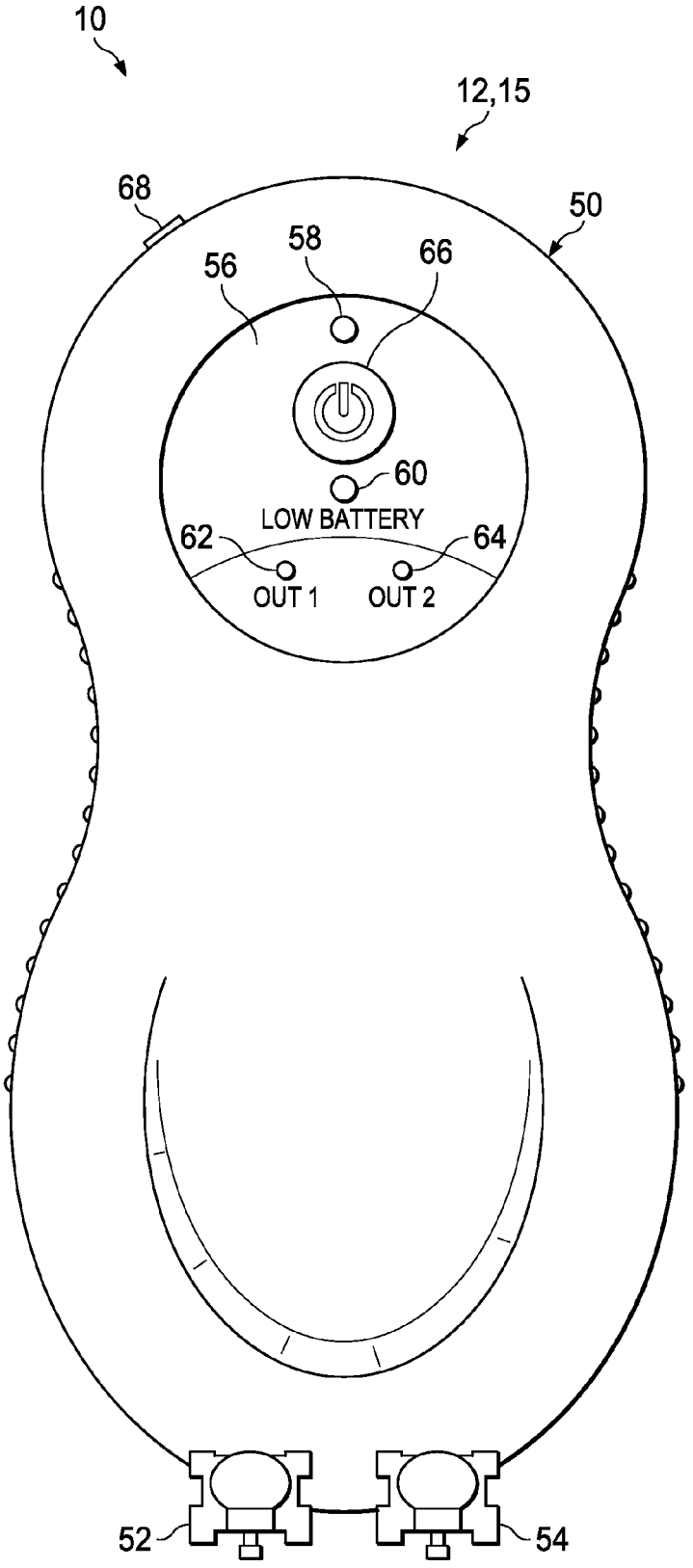


FIG. 6

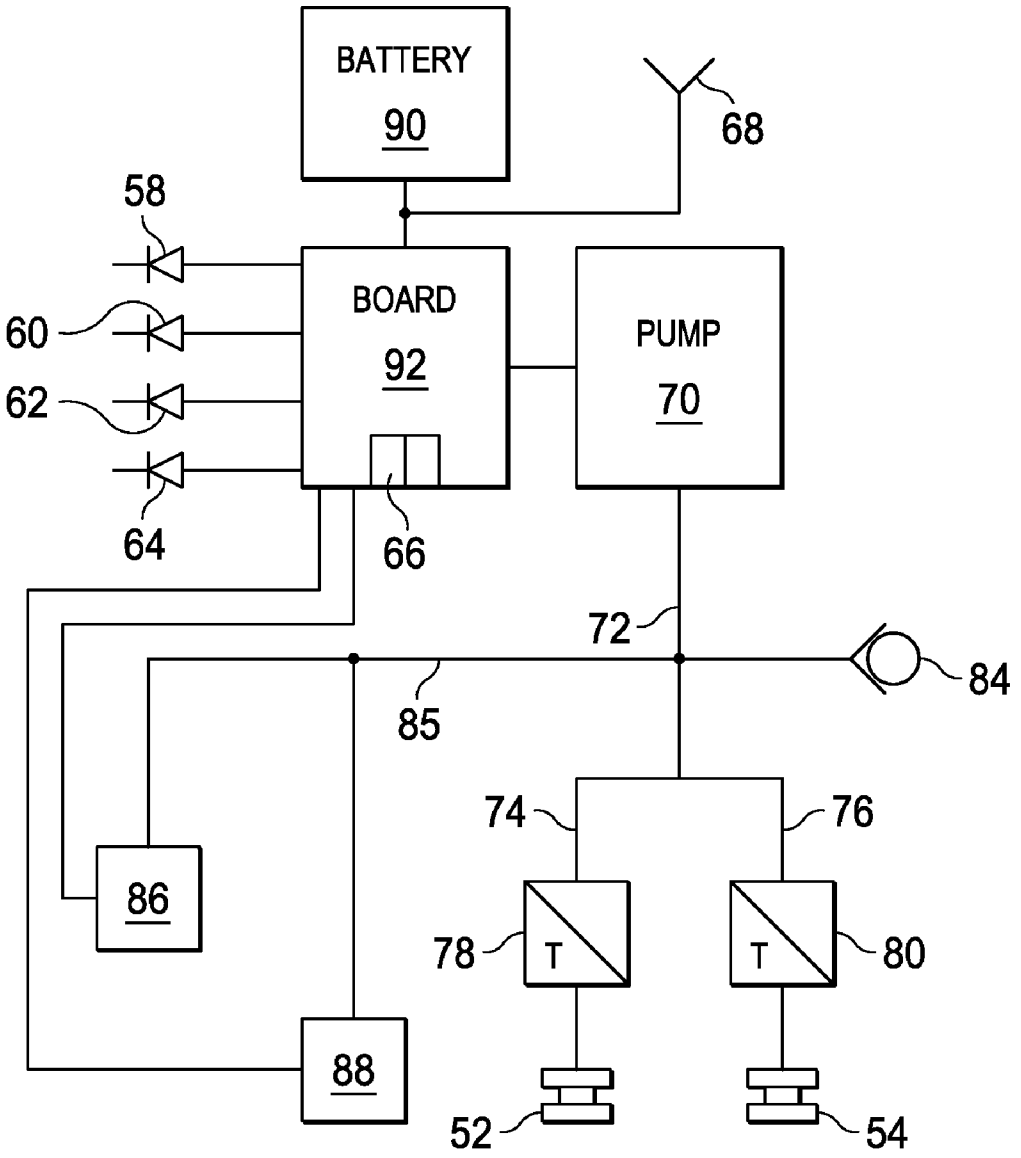

BATTERY
90
68
58
60
62
64
BOARD
92
66
PUMP
70
72
84
85
74
76
86
78
T
T
80
88
52
54

FIG. 7

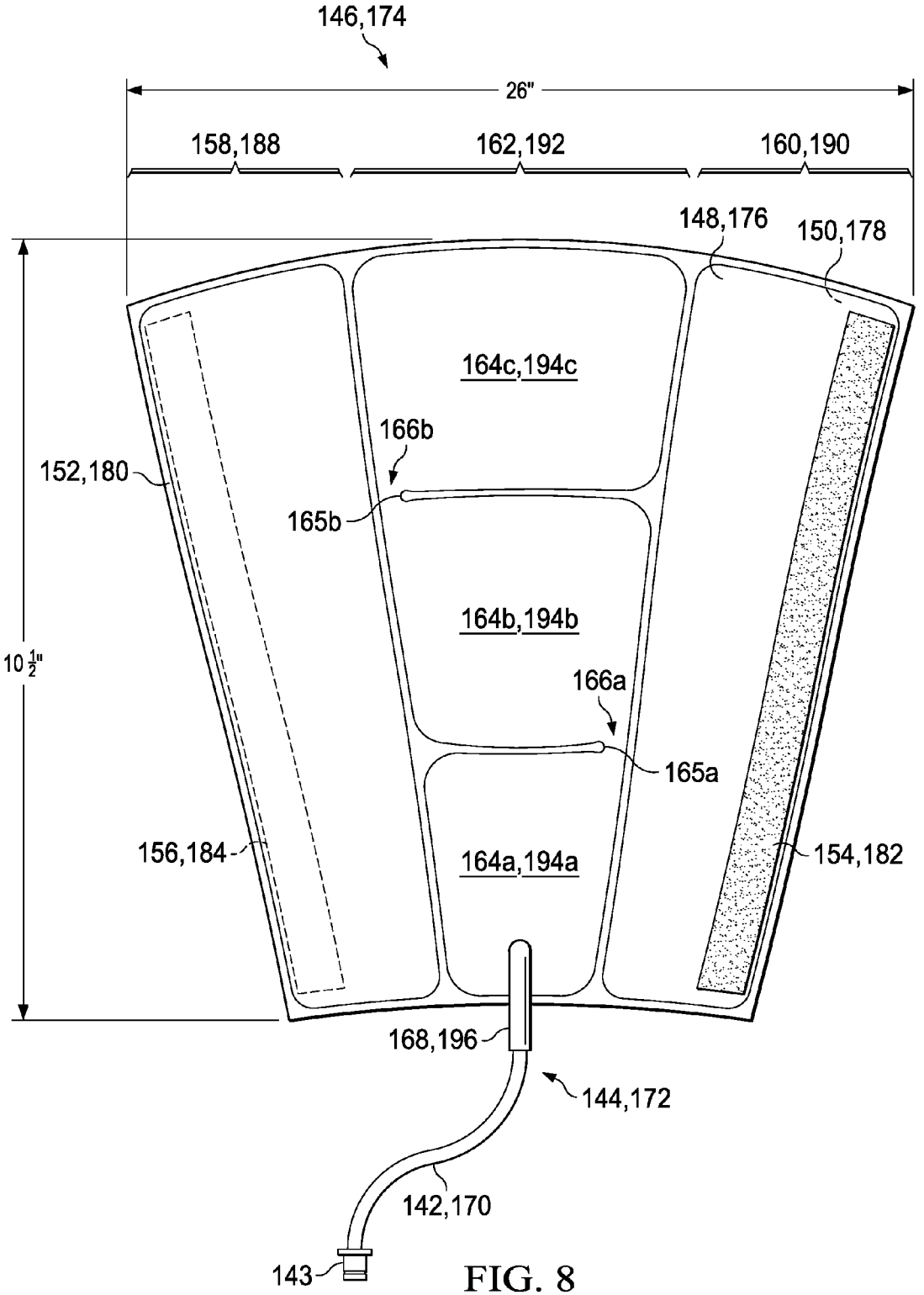

146,174
26"
158,188
162,192
160,190
148,176
150,178
164c,194c
166b
152,180
165b
164b,194b
10 1/2"
166a
165a
156,184
164a,194a
154,182
168,196
144,172
142,170
143

FIG. 8

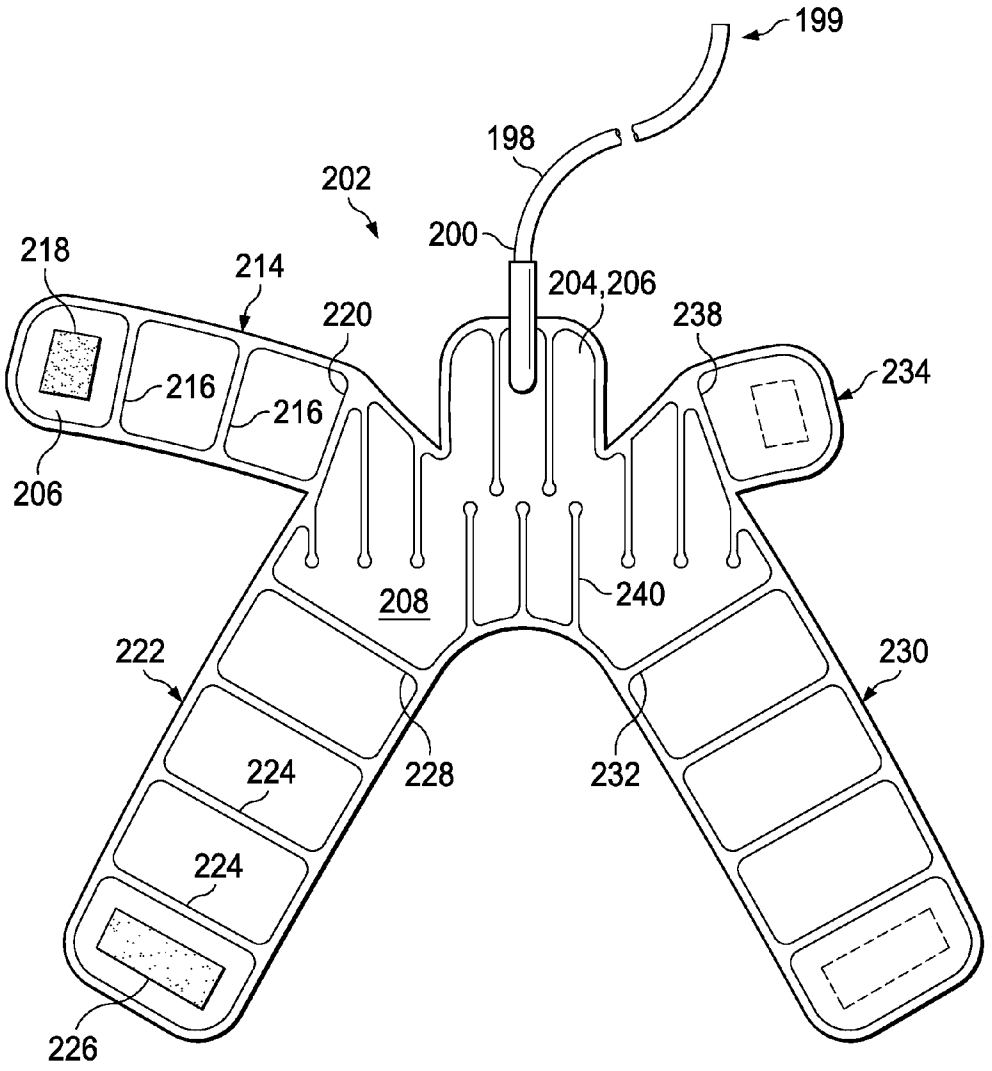

199
198
202
200
218
214
204,206
238
220
234
216
216
206
208
240
222
230
224
228
232
224
226

FIG. 9

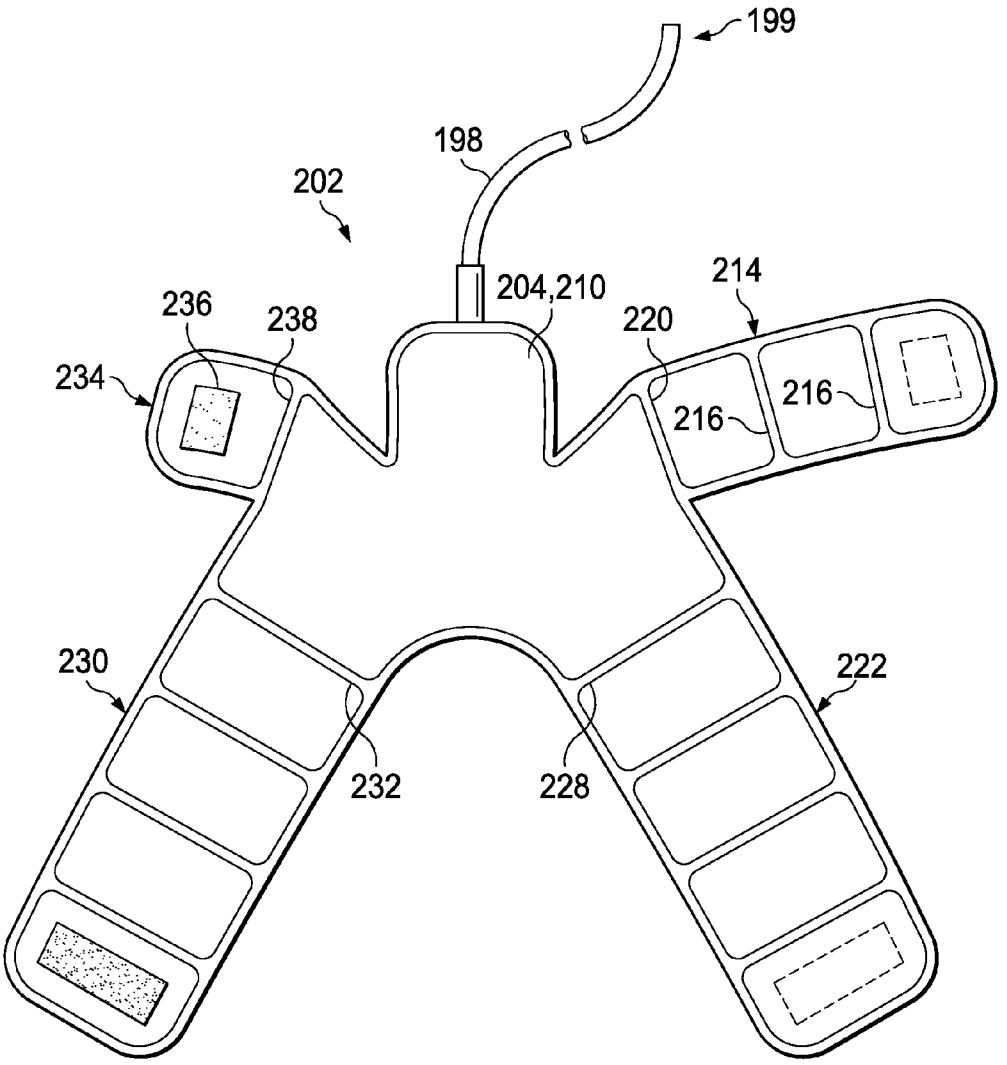


FIG. 10

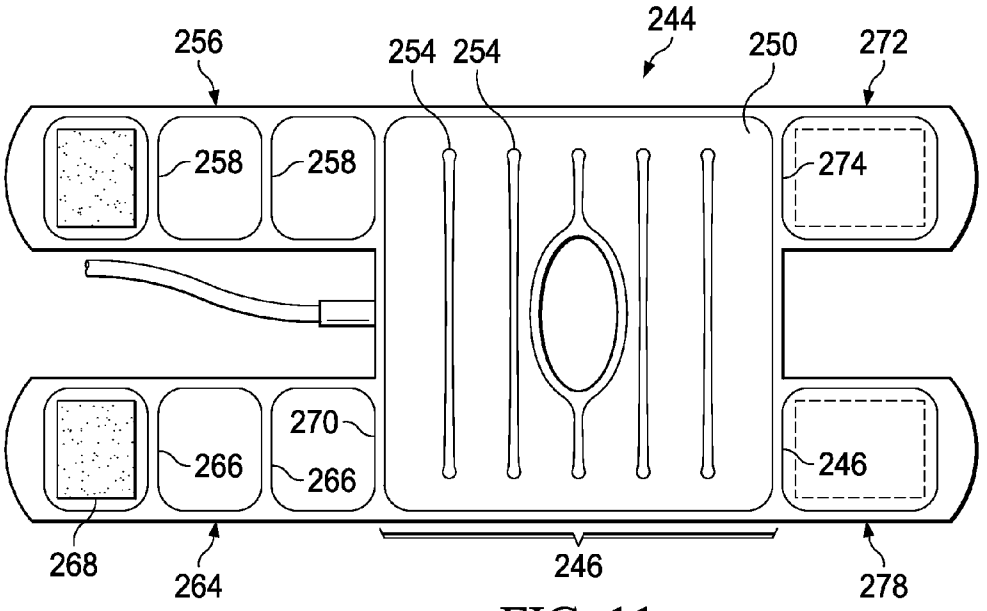

244
256
254
254
250
272
258
258
274
270
266
266
246
268
264
246
278

FIG. 11

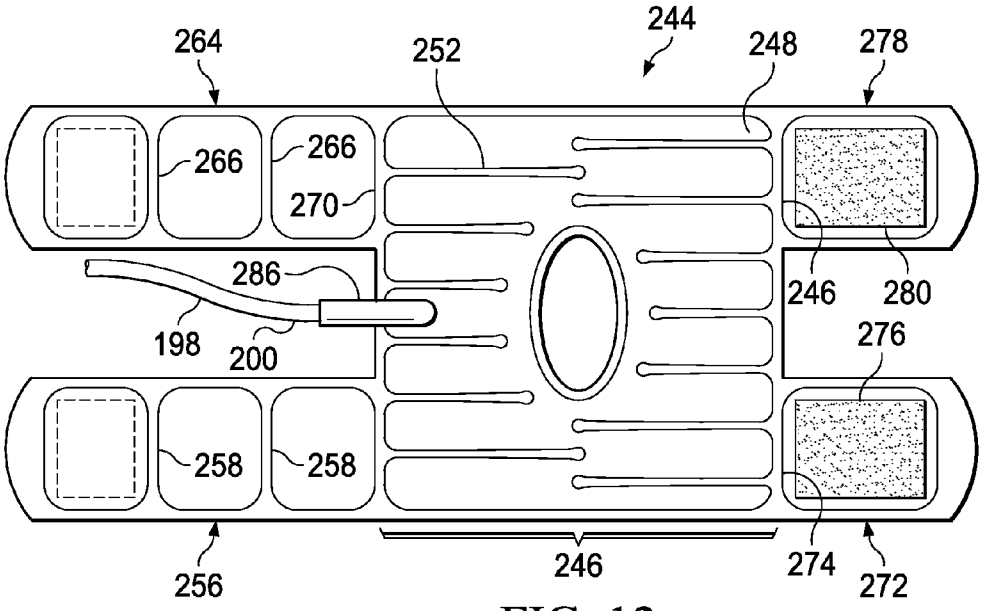

244
264
252
248
278
266
266
270
286
246
280
198
200
276
258
258
256
246
274
272

FIG. 12

DEEP VEIN THROMBOSIS THERAPY DEVICE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the priority of U.S. Provisional Patent Application No. 61/442,392 entitled "DEEP VEIN THROMBOSIS THERAPY DEVICE," filed Feb. 14, 2011, the contents of which are hereby incorporated by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to therapeutic medical devices and more particularly to devices for improving venous blood flow in a patient.

BACKGROUND OF THE INVENTION

[0003] Deep vein thrombosis (DVT) affects up to two million people in the United States each year. DVT is the formation of a blood clot or thrombus in a deep vein, such as the femoral vein or the popliteal vein, or the deep veins of the pelvis. More rarely, veins of the arm can be affected, such as in Paget-Schrötter disease. A DVT can occur without symptoms, but the affected extremity will oftentimes be painful, swollen, red, and warm, and the superficial veins may be engorged. A serious complication of a DVT is that a clot could dislodge and travel to the lungs, resulting in a pulmonary embolism.

[0004] Intermittent pneumatic compression can be of benefit to patients deemed to be at risk of deep vein thrombosis. Therefore it is desirable to provide a system for using pneumatic compression that a patient can easily self administer.

SUMMARY OF THE INVENTION

[0005] In one embodiment, the device of the invention is a portable battery-operated compression machine that provides Deep Vein Thrombosis (DVT) prophylaxis therapy, i.e., cold and compression to body parts. The device includes a compression pump that is located within a housing along with electronics that control pump operation. The compression pump is used to selectively inflate a first and a second Sequential Compression Device (SCD) sleeve that are typically placed on a patient's calves, although other body parts may also receive therapy including a patient's knee, foot, shoulder, or other area. The device has three output ports and includes a selector that allows a user to choose one of several settings. For example, settings include "single limb cuff", "double limb cuff", "auxiliary cuff only", and "single limb and auxiliary cuff", and "double limb and auxiliary cuff". The auxiliary cuff is preferably suitable for locating on a patient's joint, another limb, e.g., a patient's arm, or elsewhere. In use, the sleeves preferably inflate one at a time up to a preset pressure at a desired time interval, e.g., 50 mmHg every 60 seconds.

[0006] In one embodiment, the device has two output ports. User control is limited to an ON/OFF function. Appropriate wraps containing air bladders are connected to the unit via the two externally accessible air output ports. The control unit fills the wraps to a pre-determined pressure, e.g., 50 mmHg for a larger wrap and 130 mmHg for a smaller wrap. For example, wraps include a large wrap for affixing to a leg of a patient and a smaller wrap for affixing to a foot or ankle of a patient. Although various types of wrap configurations adapted for use on various body parts and combinations of wraps are possible, for purposes of example, "leg wrap" will be used as an example of a larger wrap and "foot wrap" will be used as an example of a smaller wrap. Preferably, a plurality of indicators, e.g., LEDs, are provided on the unit wherein the indicators correspond to an output port. The indicators preferably illuminate solid at the initiation of a fill cycle and remain illuminated solid if a leg wrap is determined to be connected, or alternatively flashes slowly if a foot wrap is determined to be connected to an output. Once a wrap is inflated to a desired pressure level, the pump and corresponding solenoid valve are turned off for a "rest" period of a pre-determined duration. The wrap then deflates through a normally open vent port of the solenoid valve. After the rest period, the next wrap is sequenced, and so on.

[0007] A preferred rest time is approximately 60 seconds between cycles for each output. Therefore, when an inflation cycle through a first output is completed or the device is otherwise reset due to no wrap being detected, then a second output will be cycled on after 25 seconds. When the second output completes its inflation, or is otherwise reset due to no wrap being detected, the first output will again be cycled after 25 seconds, and so on. Therefore, in a preferred embodiment, the time between any single output being turned off and the time the same output is again energized is greater than 50 seconds.

[0008] The device of the invention may be used to provide therapy that is beneficial for patients after surgery to alleviate pain and swelling. Typically, the device is prescribed by a physician for an individual patient who has a high risk of getting DVT due to non-ambulation during and after surgery. The patient will typically use the device for a time period of a few hours up to several weeks depending on the doctor's prescription.

[0009] A cold therapy wrap may also be placed on the affected extremity for DVT prophylasis. The cold therapy wrap preferably inflates from 20 to 50 mmHg. The cold therapy wrap is preferably gel filled.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1** is a schematic of one embodiment of the cold therapy system of the invention applied to a patient.

[0011] FIG. **2** is a plan view of a first embodiment of the device of the invention.

[0012] FIG. **3** is a side view of the device of FIG. **2**.

[0013] FIG. **4** is a bottom view of the device of FIG. **2**.

[0014] FIG. **5** is an exploded view of the device of FIG. **2**.

[0015] FIG. **6** is a plan view of a second embodiment of the device of the invention.

[0016] FIG. **7** is a schematic of the components of the device of FIG. **6**.

[0017] FIG. **8** is a plan view of a limb wrap for connection to the devices of FIGS. **1** and **6**.

[0018] FIG. **9** is a plan view of an outer side of a shoulder wrap for connection to the devices of FIG. **1**.

[0019] FIG. **10** is a plan view of the inner side of the shoulder wrap of FIG. **9** for connection to the devices of FIG. **1**.

[0020] FIG. **11** is a plan view of an inner side of the cold knee wrap of FIG. **1**.

[0021] FIG. **12** is a plan view of an outer side of the cold knee wrap of FIG. **11**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] Referring now to FIG. **1**, shown is a compression therapy system designated generally **10**. Compression therapy system **10** includes a portable compression assembly **12** (FIGS. **1-6**) having a housing **14**. Examples of portable compression assembly **12** include device **13** (FIGS. **1-5**) and device **15** (FIG. **6**).

[0023] Referring first to device **13**, pump **16** (FIG. **5**) is located in housing **14**. Tubing assembly **18** is located in housing **14**. Tubing assembly **18** is provided for receiving compressed air from pump **16**. Tubing assembly **18** preferably defines a first output **20**, second output **22**, and third output **24**. First output **20** connects to first connector **26** that protrudes from housing **14**. Second output **22** is connected to second connector **28**, which protrudes from housing **14**. Third output **24** connects to third connector **30**, which protrudes from housing **14**. First solenoid **32** is in communication with tubing assembly **18** for selectively routing compressed air from pump **16** to first connector **26**. Second solenoid **34** is in communication with tubing assembly **18** for selectively routing compressed air from pump **16** to second connector **28**. Third solenoid **36** is in communication with tubing assembly **18** for selectively routing compressed air from pump **16** to third connector **30**.

[0024] Selector **38** is preferably provided on exterior of housing **14** to be accessible by a user for controlling solenoids **32**, **34**, **36**. Selector **38** communicates with electronics board **39** for facilitating control of pump **16**, solenoids **32**, **34**, **36** and other components. Battery **40** is in communication with pump **16** for providing power to pump **16**.

[0025] Referring now to device **15** of FIGS. **6** and **7**, control unit **15** of compression system **10** preferably has housing **50**. First output port **52** and a second output port **54** extend from housing **50**. Output ports **52** and **54** are preferably normally closed valved connectors. Control unit **15** is preferably provided with a face **56** that displays a power indicator, e.g., LED **58**, a low battery indicator, e.g., LED **60**, a first output indicator, e.g., LED **62**, and a second output indicator, e.g., LED **64**. In a preferred embodiment, power switch **66** is also provided on face **56**. Housing **50** preferably also defines an access port to receive power into power input **68**.

[0026] Referring now to FIG. **7**, housing **50** contains a motorized air pump **70** that supplies pressurized air to air passageway **72**. Air passageway **72** splits into a first passageway **74** and a second passageway **76**. A first 3-way solenoid valve **78** is provided on first passageway **74**. A second 3-way solenoid valve **80** is provided on second passageway **76**. A pressure relief check valve **84** is provided upstream of valves **78** and **80**, preferably on air passageway **72**. In one embodiment, pressure relief check valve **84** is set with a 3 psi lift pressure.

[0027] First pressure switch **86** and second pressure switch **88** monitor pressure on line **85**, which communicates with line **72**. Pressure switches **86** and **88** provide switched signals to MPU of board **92** as pressure in line **72** reaches a preset trigger level.

[0028] First pressure switch **86** is preferably set to have a trigger level at 50 mmHg. A second pressure switch **88** is located on line **85** upstream of second valve **80**. Second pressure switch **88** is preferably set to have a trigger level at 130 mmHg. As will be explained in greater detail below, the MPU of board **92** monitors the time for each of switch **86** and **88** to reach the respective trigger level. The time required to read a trigger level is indicative of the volume, and therefore the type, of bladder that is connected to the output **52** or **54** associated with an active one of solenoids **78**, **80**. If no bladder is connected to an active one of output ports **52** or **54**, the result will be an instant pressure rise due to the normally closed valved connectors of output ports **52**, **54** when pump **70** is activated. If no wraps are connected to output ports **52**, **54**, then lines **72**, **76** will remain blocked. The instant pressure rise indicates "no bladder connected" and the MPU of board **92** will advance to the next step.

[0029] Battery pack **90**, preferably made up of 4 AA cells, is provided as one power source. Alternatively, device **15** can receive power externally via power input **68**. Control circuit board **92** receives power from battery pack **90** or from power input **68**.

[0030] In operation, the user control is limited to manipulating power switch **66** into one of an "On" position or an "Off" position. Appropriate "wraps" containing air bladders, discussed in greater detail below, are connected to unit **15** via externally accessible ports or outputs **52** or **54**. Control unit **15** fills the wraps to a pre-determined pressure, e.g., 50 mmHg for relatively larger leg wraps and 130 mmHg for relatively smaller foot wraps.

[0031] The appropriate output indicator, e.g., LED **62** or **64**, that corresponds to the activated wrap output illuminates "solid" at the initiation of a fill cycle, then remains illuminated solid if a leg wrap is detected or, alternatively begins flashing slowly if a foot wrap is detected on the output. Once pressure reaches a desired level, pump **70** and the corresponding valve, e.g., solenoid valve **78** or **80**, is turned off for a "rest" period of a pre-determined duration. Solenoid valves **78**, **80** are preferably "3 way", with the output being common, a normally closed connection to the valve input from the pump and a normally open connection being an exhaust to the atmosphere. The wrap then deflates through normally open vent port of the solenoid valve **78**, **80**. After the "rest" period, the next wrap is sequenced, and so on.

[0032] The "rest" time is preferably approximately 60 seconds between cycles for each output. Therefore, when air pressure delivered through output **52** completes inflation of an attached wrap or otherwise is reset due to no wrap being detected, output **54** will be cycled after 25 seconds. When air pressure delivered through output **54** completes inflation of an attached wrap or otherwise is reset due to no wrap being detected, output **52** will then again be cycled after 25 seconds, and so on.

[0033] When battery **90** or external power is initially applied to the unit via power input **68**, MPU on board **92** wakes up in "off" mode.

[0034] Power switch **66** is always active, and preferably requires being held depressed for 1 second to operate. When power switch **66** is in an "off" position, a very low current drain takes place. When power switch **66** is in an "on" position, board **92** powers up and illuminates the green Power "on" indicator **58** unless low battery conditions exist, in which case only the yellow, low battery indicator **60** will illuminate.

[0035] A delay, e.g., of three seconds, is provided before any action of pump **70** or solenoid valves **78** or **80** is provided to allow a user time to verify proper wrap connection and unit operation.

[0036] In one embodiment, device **15** operates as follows:

[0037] I. Wrap Inquiry

[0038] The first output **52** is activated and first output LED **62** illuminates "solid". Solenoid valve **78** is then powered "on" followed by pump **70** turning on, preferable less than one second later. If low pressure switch **86** provides a signal to board **92** indicating a target pressure, e.g., 50 mm Hg has been reached within a short time period, e.g., in less than a time T_1, e.g., 0.5 seconds after pump **70** starts, board **92** determines that there is no wrap connected to port **52**. First output LED **62**, pump **70** and solenoid valve **78** are then turned off. Second output **54** will then be activated at a later time, e.g., 25 seconds later.

[0039] II. High Pressure Inquiry

[0040] If the low pressure switch **86** provides a signal to board **92** indicating the target pressure, e.g., 50 mm Hg has been reached in a designated time window, e.g., greater than T_1 seconds but less than T_2 seconds, e.g., greater than 0.5 but less than 1.25 seconds, the board **92** determines that a high pressure alarm condition exists, e.g., due to a kinked hose. This condition will cause the first output LED **62** to flash rapidly and sound an audible alarm. Solenoid valve **78** and pump **70** are immediately turned off. The alarm will continue for a period of time, e.g., 2 minutes, and then board **92** of unit **15** will power off unless reset manually by turning unit **15** off via power switch **66** during the alarm.

[0041] III. Wrap Determination

[0042] If the low pressure switch **86** does not provide a signal to board **92** indicating that a trigger pressure, e.g., 50 mm Hg, has been reached within a designated period of time T_3, e.g., less than 4.5 seconds, board **92** determines that the wrap connected to first output **52** is a relatively large calf wrap instead of a comparably smaller foot wrap. Pump **70** will continue to run until low pressure switch **86** provides a signal to board **92** indicating that a trigger pressure, e.g., 50 mm Hg, has been reached, indicating the end of the first output cycle, i.e., wherein port **52** is active. Then, the second output cycle begins, i.e., wherein port **54** will be activated preferably 25 seconds later.

[0043] IV. Leak Determination

[0044] If the low pressure switch **86** does not provide a signal to board **92** indicating that a trigger pressure, e.g., 50 mm Hg, has been reached within a designated period of time T_4, e.g., 25 seconds, the board **92** determines that a low pressure alarm condition exists, e.g., due to a leak. This condition will cause the first output LED **62** to flash rapidly and sound an audible alarm. Solenoid valve **78** and pump **70** are immediately turned off. This alarm will continue for a period of time, e.g., 2 minutes, and then board **92** will power off unless reset by manually turning unit **15** off via power switch **66** during the alarm.

[0045] V. Wrap Determination

[0046] If the low pressure switch **86** provides a signal to board **92** indicating that a trigger pressure, e.g., 50 mm Hg, has been reached in a designated time window, e.g., greater than T_2 seconds but less than T_3 seconds, e.g., greater than 1.25 but less than 4.5 seconds, board **92** determines that a wrap connected is a foot wrap. At this point, the first output LED **62** begins flashing slowly, and the pump **70** will continue to run until the high pressure switch **88** provides a signal to board **92** indicating that a target pressure, e.g., 130 mm Hg has been reached, indicating the end of the first output cycle, i.e., wherein port **52** is active. Second output **54** will be activated for a period of time, e.g., 25 seconds later.

[0047] VI. Leak Determination

[0048] If, after entering the foot wrap state, high pressure switch **88** does not provide a signal to board **92** indicating that a trigger pressure, e.g., 130 mm Hg, has been reached within an additional period of time T_5, e.g., 15 seconds of run time, board **92** again detects a leak alarm condition. This condition will cause the first output LED **62** to flash rapidly and sound the audible alarm. Solenoid valve **78** and pump **70** are immediately turned off. This alarm will continue for a period of time, e.g., 2 minutes, and then board **92** will power off unless reset manually by turning unit **15** off via switch **66** during the alarm.

[0049] VII. Second Output Wrap Determination

[0050] When the second output **54** activates, second output LED **64** illuminates solid. Solenoid valve **80** is powered on followed by pump **70** turning on, preferably less than one second later. If high pressure switch **88**, provides a signal to board **92** indicating that a trigger pressure, e.g., 130 mm Hg, has been reached within a short time period T_1, e.g., in less than 0.5 seconds after pump **70** starts, board **92** determines that there is no wrap connected. Second output LED **64**, pump **70** and solenoid valve **78** are turned off, and first output **52** will be activated at a later time, e.g., 25 seconds later.

[0051] VIII. High Pressure Determination

[0052] If the low pressure switch **86** provides a signal to board **92** indicating that a trigger pressure, e.g., 50 mm Hg, has been reached within a designated time window, e.g., greater than T_1 seconds but less than T_2 seconds, e.g., greater than 0.5 seconds but less than 4.5 seconds, the board **92** determines that a high pressure alarm condition exists, e.g., due to a kinked hose. This condition will cause the second output LED **64** to flash rapidly and sound an audible alarm. Solenoid valve **80** and pump **70** are immediately turned off. This alarm will continue for a period of time, e.g., 2 minutes, and then board **92** will power off unless reset by manually turning the unit **15** off via power switch **66** during the alarm.

[0053] IX. Wrap Determination

[0054] If the low pressure switch **86** does not close within a designated period of time T_3, e.g., less than 4.5 seconds, a determination is made that the wrap connected to second output **54** is a larger wrap, e.g., a calf wrap, which possesses a relatively larger bladder, and pump **70** will continue to run until the low pressure switch **86** provides a signal to board **92** indicating that a trigger pressure, e.g., 50 mm Hg, has been reached, indicating the end of the second output cycle. First output **52** will then be activated after a designated period of time, e.g., 25 seconds later.

[0055] X. Low Pressure Determination

[0056] If low pressure switch **86** does not provide a signal to board **92** indicating that a trigger pressure, e.g., 50 mm Hg, has been reached within a designated period of time, e.g., 25 seconds, the board **92** determines that a low pressure alarm condition exists, e.g., due to a leak. This condition will cause the second output LED **64** to flash rapidly and sound an audible alarm. Solenoid valve **80** and pump **70** are immediately turned off. This alarm will continue for a period of time, e.g., 2 minutes, and then board **92** will power off unless reset manually by turning the unit **15** off via power switch **66** during the alarm.

[0057] XI. Small Wrap Determination

[0058] If low pressure switch **86** provides a signal to board **92** indicating that a trigger pressure, e.g., 50 mm Hg, has been reached in a designated period of time, e.g., greater than 1.5 seconds but less than 4.5 seconds, board **92** makes the deter-

mination that the wrap connected to port **52** is a foot wrap. At this point, the second output LED **64** begins flashing slowly. Pump **70** continues to run until high pressure switch **88** provides a signal to board **92** indicating that a trigger pressure, e.g., 130 mm Hg, has been reached, indicating the end of the second output cycle. The first output **52** will be activated a designated period of time, e.g., 25 seconds later.

[0059] XII. Leak Detection

[0060] If, after entering the "foot wrap" state, the high pressure switch **88** does not provide a signal to board **92** indicating that a trigger pressure, e.g., 130 mm Hg, has been reached within an additional period of time, e.g., within 15 seconds, board **92** will again detect a leak alarm condition. This condition will cause the second output LED **64** to flash rapidly and sound an audible alarm. Solenoid valve **80** and pump **70** are immediately turned off. The alarm will continue for a period of time, e.g., 2 minutes, and then board **92** will power off unless reset by manually turning the unit **15** off via power switch **66** during the alarm.

[0061] Unit **15** is normally powered via an external AC adapter via power input **68** with battery power pack **90** being available for temporary use. Both sources provide power to the same bus circuit of board **92**. If the voltage on the bus line drops below a certain value, e.g., below 6 volts, while unit **15** is on, the yellow low battery indicator **60** illuminates. If voltage on the line drops further to below a second value, e.g., below 5.5 volts, while unit **15** is on, unit **15** enters into a "lockout" mode wherein yellow LED **60** remains on, but power LED **58** is turned off. All functions except power switch **66** are then inhibited, i.e., put in lockout mode. In lockout mode, power switch **66** can be used to turn the unit **15** fully off, but if an attempt is made to turn unit **15** back to on while bus line is still below the second value, e.g., 5.5 volts, only the yellow LED **60** is illuminated. The MPU on board **92** can switch from "off" to "lockout", but not to "on" unless voltage on bus line is above the second value, e.g., above the 5.5 volt threshold.

[0062] To reset an alarm condition, switch **66** must be turned off. If switch **66** is not manually turned off within a designated period of time, e.g., 2 minutes of an alarm condition occurring, unit **15** automatically turns itself off.

[0063] Referring now to FIG. **8**, first compressed air line **142** is provided having an inlet end **143** for affixing to first connector **26** for receiving compressed air from pump **16** or to one of connectors **52**, **54** of device **15**. First compressed air line **142** has an exit end **144** for delivering compressed air. In a preferred embodiment, first compressed air line **142** has a ⅛ inch inner diameter and is 86 inches long.

[0064] First limb wrap **146** is affixed to exit end **144** of first compressed air line **142**. In one embodiment, first limb wrap **146** has a maximum width of 26 inches and a height of 10½ inches. First limb wrap **146** has an inside sheet **148** and an outside sheet **150** that are joined together by seals, such as heat seals. For example, border seal **152** joins a perimeter of inside sheet **148** and outside sheet **150**. In a preferred embodiment, border seal **152** is preferably ¼ inch wide. Outside sheet **150** is provided with hook member patch **154** having a plurality of hook fasteners. Hook member patch **154** is preferably 1½ inches wide. Inside sheet **148** is preferably provided with loop member patch **156** having a plurality of loop fasteners for selectively engaging the plurality of hook fasteners on hook member patch **154** once first limb wrap **146** is wrapped around a limb, e.g. a calf portion, of a patient. In a preferred embodiment, loop member patch **156** is 1½ inches wide.

[0065] First limb wrap **146** defines a plurality of areas demarcated by seal lines. The plurality of areas include a first side area **158**, a second side area **160**, and inflatable area **162** that is preferably between first side area **158** and second side area **160**. Inflatable area **162** preferably defines three interconnected chambers **164***a*, **164***b*, and **164***c*, separated by seal lines and connected by air passages **166***a* and **166***b*. Stem **168** is provided for engaging exit end **144** of first compressed air line **142**. Stem **168** is connected to one of interconnected chambers **164***a*, **164***b*, and **164***c* of inflatable area **162** for delivering compressed air to interconnected chambers **164***a*, **164***b*, and **164***c*.

[0066] Second compressed air line **170** has an inlet end for affixing to second connector **128** for receiving compressed air from pump **16**. Second compressed air line **170** has an exit end **172** for delivering compressed air. In a preferred embodiment, second compressed air line **170** has a ⅛ inch inner diameter and is 86 inches long.

[0067] Second limb wrap **174** is affixed to exit end **172** of second compressed air line **170**. Second limb wrap **174** has an inside sheet **176** and an outside sheet **178** joined together with heat seals. For example, inside sheet **176** and outside sheet **178** may be joined with border seal **180**. In a preferred embodiment, border seal **180** is ¼ inches wide. Outside sheet **178** is preferably provided with hook member patch **182** having a plurality of hook fasteners. Hook member patch **182** is preferably 1½ inches wide. Inside sheet **176** is preferably provided with loop member patch **184** having a plurality of loop fasteners for selectively engaging the plurality of hook fasteners on hook member patch **182**. In a preferred embodiment, loop member patch member **184** is 1½ inches wide.

[0068] Second limb wrap **174** defines a plurality of areas demarcated by seal lines. The plurality of areas includes first side area **188**, second side area **190** and inflatable area **192** between first side area **188** and second side area **190**. Inflatable area **192** defines three interconnected chambers **194***a*, **194***b*, and **194***c* separated by seal lines. A stem **196** is connected to one of interconnected chambers **194***a*, **194***b*, and **194***c*. Stem **196** is provided for engaging exit end **172** of second compressed air line **170**.

[0069] Referring now to FIGS. **9** and **10**, third compressed air line **198** has an inlet end **199** affixed to third connector **30** (FIGS. **1**, **3**, **5**) for receiving compressed air from pump **16**, or for affixing to one of connectors **52**, **54** of device **15**. Third compressed air line **198** has an exit end **200** for delivering compressed air. In a preferred embodiment, third compressed air line **198** has an inner diameter of ⅛ inch and length of 86 inches.

[0070] Cold therapy shoulder wrap **202** has a chamber portion **204** having a fluid chamber side **206** for containing fluid **208**. Chamber portion **204** additionally has an air chamber side **210** for receiving compressed air from exit end **200** of third compressed air line **198**. Fluid chamber side **206** and air chamber side **210** are separated by a barrier member, not shown. Cold therapy shoulder wrap **202** additionally has first wrap extension **214** extending therefrom. First wrap extension **214** defines a plurality of dividing seals **216**. First wrap extension **214** preferably has a Velcro® compatible loop material **218** on fluid chamber side **206**. An interface between

first wrap extension **214** and chamber portion **204** defines first strap seal **220**. In a preferred embodiment, first strap seal **220** has a width of ⅛ inch.

[0071] Cold therapy shoulder wrap **202** additionally has a second wrap extension **222** extending therefrom. Second wrap extension **222** defines a plurality of divider seals **224**. In a preferred embodiment, second wrap extension **222** is 22 inches long by 6 inches wide. Preferably, second wrap extension **222** has a hook portion of a hook and loop fastener **226** affixed to fluid chamber side **206** proximate a terminal end of second wrap extension **222**. An interface between second wrap extension **222** and chamber portion **204** defines second strap seal **228**. Second strap seal **228** preferably has a width of ¼ inch.

[0072] Cold therapy shoulder wrap **202** is preferably provided with third wrap extension **230** extending therefrom. An interface between third wrap extension **230** and chamber portion **204** defines third strap seal **232**. Third strap **232** preferably has a width of ¼ inch. Cold therapy shoulder wrap **202** is additionally preferably provided with tab extension **234**. Tab extension **234** is preferably provided with a hook portion of a hook and loop fastener **236** and is affixed to air chamber side **210** of tab extension **234**. Tab extension **234** preferably has dimensions of 2 inches by 3 inches. An interface between tab extension **234** and chamber body **204** defines strap seal **238**. Strap seal **238** preferably has a width of ¼ inch.

[0073] Fluid chamber side **206** of chamber portion **204** is preferably provided with a plurality of seal barriers **240** for forming a plurality of interconnected chambers **242** for functioning as baffles for fluid **208**. In a preferred embodiment, seal barriers **240** have a width of ⅛ inch.

[0074] In a preferred embodiment, fluid **208** is located in fluid chamber side **206** of chamber portion **204** of cold therapy shoulder wrap **202** is a gel comprising water, propylene glycol, polyacrylamide, and preservatives. The gel is available from Trann Technologies, Inc., 12526 US Highway 90, Mossy Head, Fla. 32434.

[0075] Referring now to FIGS. **11** and **12**, in a second embodiment of cold therapy system **10**, a cold therapy knee wrap **244** may be provided. Preferably, cold therapy knee wrap **244** has a chamber portion **246**. Chamber portion **246** has an air chamber side **248** for receiving compressed air from exit end **200** of third compressed air line **198** that may be affixed to ports **26**, **28**, **30** of device **13** or ports **52**, **54** of device **15**. Chamber portion **246** also has a fluid chamber side **250** to contain fluid **208**. Air chamber side **248** and fluid chamber side **250** are separated by a divider member (not shown). Air chamber side **248** preferably defines a plurality of seals **252**.

[0076] Fluid chamber side **250** of chamber portion **246** preferably defines a plurality of seals **254**. Fluid chamber side **250** is provided for receiving fluid **208**. First wrap extension **256** extends from chamber portion **246**. First wrap extension **256** preferably has dimensions of 11 inches by 5 inches. First wrap extension **256** defines a plurality of divider seals **258**. First wrap extension **256** preferably has a Velcro® compatible loop material **260** on fluid chamber side **250**. An interface between first wrap extension **256** and chamber portion **246** defines first strap seal **262**.

[0077] Second wrap extension **264** extends from chamber portion **246** and has a preferred dimension of 11 inches by 5 inches. Second wrap extension **264** defines a plurality of divider seals **266**. Second wrap extension **264** preferably has a Velcro® compatible loop material **268** on fluid chamber side **250**. An interface between second wrap extension **264** and chamber portion **246** defines second strap seal **270**.

[0078] First tab extension **272** extends from chamber portion **246**. An interface between first tab extension **272** and chamber portion **246** defines third strap seal **274**. First tab extension **272** has preferred dimensions of 5 inches by 6 inches. First tab extension **272** preferably has a hook portion of a hook and loop fastener **276** affixed to air chamber side **248**.

[0079] Second tab extension **278** extends from chamber portion **246**. Second tab extension **278** has preferred dimensions of 5 inches by 6 inches. Second tab extension **278** is preferably provided with a hook portion of hook and loop fastener **280** affixed to air chamber side **248**. An interface between second tab extension **278** and chamber portion **246** defines a fourth strap seal.

[0080] Air chamber side **248** of chamber portion **246** of cold therapy knee wrap **244** is preferably provided with interior seals **254** for forming a plurality of areas **284** into which compressed air is dispersed. Fluid chamber side **250** has a plurality of interior seals **254** that function as baffles to position fluid **208**. Angle connector **286** extends from air chamber side **248** of chamber portion **246** for connecting to exit end **200** of third compressed air line **198**. Angle connector **286** delivers compressed air to air chamber portion **246**.

[0081] In use, device **13** of cold therapy system **10** operates as follows:

[0082] In single limb cuff mode, first solenoid **32** is powered on and pump **16** pressurizes a limb cuff, e.g., first limb wrap **146**, to a desired pressure, e.g., 20 mmHg to 50 mmHg, preferably 50 mmHg. Pump **16** is then turned off to allow first limb wrap **146** to deflate. Pump **16** then powers on after a desired time interval, e.g., 60 seconds, to repeat. Although preferred ranges of inflation intervals are listed herein, inflation intervals may be changed in the software as desired, e.g., to accommodate wraps with larger bladders or to adjust cycle time via "rest period" variations.

[0083] In double limb cuff mode, first solenoid **32** is powered on and pump **16** pressurizes a limb wrap, e.g., first limb wrap **146**, to a desired pressure, e.g., 50 mmHg, preferably 50 mmHg. Pump **16** is then turned off to allow the first limb wrap **146** to deflate. Solenoid **34** is then powered on after a desired time interval, e.g., 25 seconds. Pump **16** then pressurizes a second limb wrap **174** to a desired pressure, e.g., 20 mmHg to 50 mmHg, preferably 50 mmHg. Pump **16** is then turned off. Pump **16** is then powered on after a desired time interval, e.g., 25 seconds, to repeat the process.

[0084] In auxiliary cuff only mode, solenoid **36** is powered on and pump **16** pressurizes an auxiliary cuff, e.g., cold therapy shoulder wrap **202** or cold therapy knee wrap **244**, to a desired pressure, e.g., 20 mmHg to 50 mmHg, preferably 50 mmHg. Preferably the maximum fill time is 60 seconds. Pump **16** is then turned off to allow joint wrap **202** or **244** to deflate. Pump **16** is then powered on after a desired time interval, e.g., 60 seconds, to repeat.

[0085] In single limb+auxiliary cuff mode, solenoid **32** is powered on and pump **16** pressurizes a limb cuff, e.g., first limb wrap **146**, to a desired pressure, e.g., 50 mmHg, preferably 50 mmHg. Pump **16** is then turned off to allow first limb wrap **146** to deflate. Solenoid **36** is then powered on after a desired time interval, e.g., 25 seconds. Pump **16** then pressurizes the auxiliary cuff, e.g., cold therapy shoulder wrap **202** or cold therapy knee wrap **244**, to maintain a desired pressure,

e.g., 20 mmHg to 50 mmHg, preferably 50 mmHg. Pump **16** is then turned off. After a desired time interval, e.g., 25 seconds, pump **16** is powered on to repeat the process.

[0086] In double limb and auxiliary cuffs mode, solenoid **32** is powered on and pump **16** pressurizes first limb wrap **146** to a desired pressure, e.g., 50 mmHg, preferably 50 mmHg. Pump **16** is then turned off to allow first limb wrap **146** to deflate. Solenoid **34** is then powered on after a desired time interval, e.g., 15 seconds. Pump **16** then pressurizes second limb wrap **174** to a desired pressure, e.g., 20 mmHg to 50 mmHg, preferably 50 mmHg. Pump **16** is then turned off. Solenoid **36** is then powered on after a desired time interval, e.g., 15 seconds and pump **16** pressurizes an auxiliary cuff, e.g., cold therapy shoulder wrap **202** or cold therapy knee wrap **244**, to a desired pressure, e.g., 20 mmHg to 50 mmHg, preferably 50 mmHg. Pump **16** is turned then off to allow auxiliary wrap **202** or **244** to deflate. Pump **16** is then powered on after a desired time interval, e.g., 15 seconds, to repeat.

[0087] Thus, the present invention is well adapted to carry out the objectives and attain the ends and advantages mentioned above as well as those inherent therein. While presently preferred embodiments have been described for purposes of this disclosure, numerous changes and modifications will be apparent to those of ordinary skill in the art. Such changes and modifications are encompassed within the spirit of this invention as defined by the claims.

What is claimed is:

1. A compression therapy system comprising:
- a portable compression device having a housing;
- a pump in said housing;
- a tubing assembly in said housing, said tubing assembly for receiving air from said pump, said tubing assembly having a first output and a second output;
- a first solenoid in communication with said tubing assembly for selectively routing compressed air from said pump to said first output;
- a second solenoid in communication with said tubing assembly for selectively routing compressed air from said pump to said second output;
- a power source in communication with said pump;
- a first wrap affixed to said first output;
- a second wrap affixed to said second output;

2. The compression therapy system according to claim **1** wherein:
- said tubing assembly has a third output;
- a third solenoid in communication with said tubing assembly for selectively routing compressed air from said pump to said third output;

3. The compression therapy system according to claim **2** further comprising:
- a selector accessible by a user for controlling said solenoids.

4. The compression therapy system according to claim **2** further comprising:
- a third wrap affixed to said third output.

5. The compression therapy system according to claim **4** wherein:
- said third wrap is a cold therapy wrap.

6. The compression therapy system according to claim **5** wherein:
- said third wrap defines a fluid chamber that contains a gel.

7. The compression therapy system according to claim **1** wherein:
- one of said first wrap and said second wrap is a relatively smaller wrap; and
- the other of said first wrap and said second wrap is a relatively larger wrap.

8. The compression therapy system according to claim **1** further comprising:
- a timer for timing wrap inflation events for determining which of said first wrap and said second wrap is larger or smaller.

9. The compression therapy system according to claim **8** wherein:
- said inflation events are compared to time thresholds selected from the group consisting of a first time threshold indicating that no wrap is present, a second time threshold indicating that a high pressure alarm condition exists, a third time threshold indicating that a wrap is a large wrap, a fourth time threshold indicating a low pressure alarm condition exists, and a fifth time threshold indicating a low pressure alarm condition exists.

10. The compression therapy system according to claim **8** further comprising:
- a high pressure switch for providing a signal to indicate when a high pressure target threshold is reached;
- a low pressure switch for providing a signal to indicate when a low pressure target threshold is reached.

11. A method of inflating therapy wraps comprising:
- activating a pump;
- timing an interval until a wrap inflation event occurs.

12. The method according to claim **11** further comprising:
- comparing said inflation event to a time threshold selected from the group consisting of a first time threshold indicating that no wrap is present, a second time threshold indicating that a high pressure alarm condition exists, a third time threshold indicating that a wrap is a large wrap, a fourth time threshold indicating a low pressure alarm condition exists, and a fifth time threshold indicating a low pressure alarm condition exists.

13. The method according to claim **11** wherein:
- said step of timing said wrap inflation event comprises determining if a wrap is in communication with said pump.

14. The method according to claim **11** further comprises:
- after said step of timing said wrap inflation event, determining if a high pressure condition exists.

15. The method according to claim **14** wherein:
- said high pressure condition is due to a line kink.

16. The method according to claim **11** further comprising:
- after said step of timing said wrap inflation event, determining if one of said attached wraps is a relatively large wrap or a relatively smaller wrap.

17. The method according to claim **11** further comprising:
- after said step of timing said wrap inflation event, determining if a low pressure alarm condition exists.

18. The method according to claim **17** wherein:
- said low pressure alarm condition is due to a leak.

* * * * *